<110> Brownlie, John
       Chalker, Victoria J.
       Erles, Kerstin

<120> CANINE RESPIRATORY CORONAVIRUS (CRCV) SPIKE PROTEIN, POLYMERASE AND
HEMAGGLUTININ/ESTERASE

<130> ERP02.003APC

<140> US 10/522,513
<141> 2006-06-22

<150> PCT/GB03/02832
<151> 2003-07-01

<150> GB 0217434.0
<151> 2002-07-27

<160> 52

<170> PatentIn version 3.1

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Asn Gly Tyr Tyr Pro Thr Ser Gly Ser Thr Tyr Arg Asn Met Ala Leu
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Lys Gly Thr Leu Leu Leu Ser Thr Leu Trp Phe Lys Pro Pro Phe Leu
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Ile Lys Asp Gly Val Val Tyr Ser Glu Phe Pro Ala Ile Thr Ile Gly
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Gln Tyr Thr Met Cys Asp Tyr Pro His Thr Met Cys His Pro Asn Leu
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Gly Asn Lys Arg Ile Glu Leu Trp His Trp Asp Thr Gly Val Val Pro
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Cys Leu Tyr Lys Arg Asn Phe Thr Tyr Asp Val Asn Ala Asp Tyr Leu
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Tyr Ser His Phe Tyr Gln Glu Gly Gly Thr Phe Tyr Ala Tyr Phe Thr
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Asp Thr Gly Val Val Thr Lys Phe Leu Phe His Val Tyr Leu Gly Thr
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Val Leu Ser His Tyr Tyr Val Met Pro Leu Thr Cys Asn Ser Ala Met
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Asp Phe Met Ser Glu Ile Lys Cys Lys Thr Leu Ser Ile Ala Pro Ser
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Thr Gly Val Tyr Glu Leu Asn Gly Tyr Thr Val Gln Pro Ile Ala Asp
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Val Tyr Arg Arg Ile Pro Asn Leu Pro Asp Cys Asn Ile Glu Ala Trp
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Leu Asn Asp Lys Ser Val Pro Ser Pro Leu Asn Trp Glu Arg Lys Thr
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Phe Ser Asn Cys Asn Phe Asn Met Ser Ser Leu Met Ser Phe Ile Gln
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Asn Arg Arg Phe Gly Phe Thr Glu Gln Ser Val Phe Lys Pro Gln Pro
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Lys Ala Pro Thr Asn Phe Cys Pro Cys Lys Leu Asn Gly Ser Leu Cys
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Val Gly Ser Gly Phe Gly Ile Asp Ala Gly Tyr Lys Asn Ser Gly Ile
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Gly Thr Cys Pro Ala Gly Thr Asn Tyr Leu Thr Cys Tyr Asn Ala Asn
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Gln Cys Asp Cys Leu Cys Thr Pro Asp Pro Ile Leu Ser Lys Ser Thr
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Gly Pro Tyr Lys Cys Pro Gln Thr Lys Tyr Leu Val Gly Ile Gly Glu
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His Cys Ser Gly Leu Ala Ile Lys Ser Asp Tyr Cys Gly Gly Asn Pro
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Cys Thr Cys Gln Pro Lys Ala Phe Leu Gly Trp Ser Val Asp Ser Cys
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Leu Gln Gly Asp Arg Cys Asn Ile Phe Ala Asn Phe Ile Leu His Gly
            595                 600                 605

Val Asn Ser Gly Thr Thr Cys Ser Thr Asp Leu Gln Lys Ser Asn Thr
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Asp Ile Ile Leu Gly Val Cys Val Asn Tyr Asp Leu Tyr Gly Ile Thr
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Tyr Leu Thr Asn Arg Thr Phe Met Ile Arg Ser Cys Tyr Ser Gly Arg
          675             680             685

Val Ser Ala Gly Phe His Ser Asn Ser Ser Glu Pro Ala Leu Leu Phe
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Arg Asn Ile Lys Cys Asn Tyr Val Phe Asn Asn Thr Leu Ser Arg Gln
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Leu Gln Pro Ile Asn Tyr Phe Asp Ser Tyr Leu Gly Cys Val Val Asn
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Ala Asp Asn Ser Thr Ser Ser Ser Val Gln Thr Cys Asp Leu Thr Val
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Gly Ser Gly Tyr Trp Gly Asp Tyr Ser Thr Gln Arg Arg Ser Arg Arg
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Thr Ile Thr Thr Gly Tyr Arg Phe Thr Asn Phe Glu Pro Phe Thr Val
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Asn Pro Val Asn Asp Ser Leu His Pro Val Gly Gly Leu Tyr Glu Ile
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Gln Ile Pro Ser Glu Phe Thr Ile Gly Asn Met Glu Glu Phe Ile Gln
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Thr Arg Ser Pro Lys Val Thr Ile Asp Cys Pro Val Phe Val Cys Gly
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Asp Tyr Ala Ala Cys Lys Ser Gln Leu Val Glu Tyr Gly Ser Phe Cys
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Asp Asn Ile Asn Ala Ile Leu Thr Glu Val Asn Glu Leu Leu Asp Thr
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Thr Gln Leu Gln Val Ala Asn Ser Leu Met Asn Gly Val Thr Leu Ser
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Thr Lys Leu Lys Asp Gly Phe Asn Phe Asn Val Asp Asp Ile Asn Phe
          885             890             895
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Page 7

Ser Pro Val Leu Gly Cys Leu Gly Ser Glu Cys Asn Lys Val Ser Ser
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Arg Ser Ala Ile Glu Asp Leu Leu Phe Ser Lys Val Lys Leu Ser Asp
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Val Gly Phe Val Asp Ala Tyr Asn Asn Cys Thr Gly Gly Ala Glu Ile
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Arg Asp Leu Ile Cys Val Gln Ser Tyr Asn Gly Ile Lys Val Leu Pro
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Pro Leu Leu Ser Glu Asn Gln Ile Ser Gly Tyr Thr Leu Ala Ala Thr
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Val Leu Thr Gln Asn Gln Lys Leu Ile Ser Asn Ala Phe Asn Asn
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Ala Leu Asp Ala Ile Gln Glu Gly Phe Asp Ala Thr Asn Ser Ala
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Leu Val Lys Ile Gln Ala Val Val Asn Ala Asn Ala Glu Ala Leu
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Asn Asn Leu Leu Gln Gln Leu Ser Asn Lys Phe Gly Ala Ile Ser
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Ala Ser Leu Gln Glu Ile Leu Ser Arg Leu Asp Ala Leu Glu Ala
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Gln Ala Gln Ile Asp Arg Leu Ile Asn Gly Arg Leu Thr Ala Leu
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Asn Ala Tyr Val Ser Gln Gln Leu Ser Asp Ser Thr Leu Val Lys
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Phe Ser Ala Ala Gln Ala Met Glu Lys Val Asn Glu Cys Val Lys
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Ser Gln Ser Ser Arg Ile Asn Phe Cys Gly Asn Gly Asn His Ile
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Phe Ser  Tyr Val Pro Thr Lys  Tyr Val Thr Ala Lys   Val Ser Pro
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Gly Leu  Cys Ile Ala Gly Asp  Arg Gly Ile Ala Pro   Lys Ser Gly
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Tyr Phe  Val Asn Val Asn Asn  Thr Trp Met Phe Thr   Gly Ser Gly
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Tyr Tyr  Tyr Pro Glu Pro Ile  Thr Gly Asn Asn Val   Val Val Met
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Ser Thr  Cys Ala Val Asn Tyr  Thr Lys Ala Pro Asp   Val Met Leu
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Asn Ile  Ser Thr Pro Asn Leu  Pro Asp Phe Lys Glu   Glu Leu Asp
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Gln Trp  Phe Lys Asn Gln Thr  Leu Met Ala Pro Asp   Leu Ser Leu
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Asp Tyr  Ile Asn Val Thr Phe  Leu Asp Leu Gln Asp   Glu Met Asn
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Arg Leu  Gln Glu Ala Ile Lys  Val Leu Asn His Ser   Tyr Ile Asn
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Leu Lys  Asp Ile Gly Thr Tyr  Glu Tyr Tyr Val Lys   Trp Pro Trp
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Tyr Val  Trp Leu Leu Ile Gly  Leu Ala Gly Val Ala   Met Leu Val
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Leu Leu  Phe Phe Ile Cys Cys  Cys Thr Gly Cys Gly   Thr Ser Cys
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Phe Lys  Lys Cys Gly Gly Cys  Cys Asp Asp Tyr Thr   Gly His Gln
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Lys Cys Leu Lys Ser Ile Ala Ala Thr Arg Gly Val Pro Val Val Ile
            35   40   45

Gly Thr Thr Lys Phe Tyr Gly Gly Trp Asp Asp Met Leu Arg Arg Leu
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Cys

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                20   25   30

Lys Cys Leu Lys Ser Ile Ala Ala Thr Arg Gly Val Pro Val Val Ile
            35   40   45

Gly Thr Thr Lys Phe Tyr Gly Gly Trp Asp Asp Met Leu Arg Arg Leu
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Cys

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Lys Cys Leu Lys Ser Ile Ala Ala Thr Arg Gly Val Pro Val Val Ile
        35                  40                  45

Gly Thr Thr Lys Phe Tyr Gly Gly Trp Asp Asp Met Leu Arg Arg Leu
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Ile Lys Asp Val Asp Asn Pro Val Leu Met Gly Trp Asp Tyr Pro Lys
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Tyr His Gln Lys His Leu Lys Ser Ile Ala Ala Thr Arg Asn Ala Thr
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Val Val Ile Gly Ser Thr Lys Phe Tyr Gly Gly Trp Asp Asn Met Leu
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tctatacaac caggtcagca ttgccctggc ttgggtcttg tggaggatga ttgctctggt  1680
aatccttgca cttgtaaacc acaggctttc ataggctgga gttcagaaac ttgtttgcaa  1740
aatggtaggt gtaatatttt tgctaatttt atttttgaatg atgttaatag cggtactacc  1800
tgttctactg atttacaaca gggtaactact aatattacta ctgatgtttg tgttaattat  1860
gacctatatg gcattacagg ccagggcata cttatagaag ttaatgccac gtattataat  1920
agttggcaga atcttcttta tgattctagt ggtaatctct atggcttag agattattta  1980
tcaaatagaa cctttcttat tcgtagctgc tatagtggaa gagtttcagc agtctttcat  2040
gctaactctt ctgaaccagc tttgatgttt cgtaatctta aatgcagcca cgttttttaat  2100
tataccattt taagacaaat acagcttgtt aattattttg atagttacct tggttgtgtt  2160
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gttaatgctt ataataatac agctagtgct gtaagtactt gtgatttaac cgttggtagc    2220

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cgctttacta attttgaacc atttgccgct aatttggtaa atgatagtat agaacctgtt     2340

ggtggtttgt atgaaataca gataccttca gagtttacca ttggtaattt agaagaattc    2400

attcaaacga gttccctaa ggttactata gattgtgcta catttgtttg tggtgactat      2460

gctgcatgta gacaacagtt agctgagtat ggtagttttt gtgagaacat taatgctata    2520

ctcatagaag taaatgaact acttgacact acacagttgc aagtagctaa tagtttaatg    2580

aatggagtca ccctagtac taagattaag gatgggatta atttcaatgt tgacgatatc      2640

aacttctcct ctgtattagg ttgtttagga agcgaatgta acagagcttc cactagatct    2700

gctatagagg atttacttt tgataaagta aaattgtctg atgtcggttt tgtacaggcc      2760

tataataact gcactggagg agccgaaatt agggatctca tttgtgtgca aagttataat    2820

ggtatcaaag tgttgcctcc attgttatct gaaaatcaga ttagtggtta cacttcggca    2880

gccaccgctg ctagcctatt tcctcctgg acagctgcag caggtgtacc attttattta      2940

aatgttcagt atcgtataaa tgggcttggc gtcaccatgg atgtgctaag ccaaaaccaa    3000

aagcttattg ctagtgcatt taacaacgct cttgattcta tccaggaagg gttcgacgca    3060

accaattctg ctttagttaa aattcaggct gttgttaatg caaatgctga agcacttaat    3120

aacttattgc agcaactctc taacaggatt ggtgccataa gtgcctcttt acaagaaatt    3180

ttatccaggc tcgatgctct tgaagctaaa gctcagatag acagacttat taatgggcgt    3240

ctcaccgctc ttaatgctta tgtttctcag cagcttagtg attctacact agtaaaattt    3300

agtgcagcac aagctattga gaaagttaat gaatgtgtta aaagccaatc atctaggata    3360

aatttctgtg gtaatggtaa tcatattata tcattagtac agaatgctcc atatggtttg    3420

tattttatcc attttagcta tgtccccacc aagtatgtta cagcaaaggt tagtcctggt    3480

ttgtgcattg ctggcgatat aggaatatcg cctaagagtg gttatttat taatgtaaat     3540

aactcttgga tgttcactgg tagtggctat tactaccctg aacctataac ccaaaataat    3600

gttgttgtga tgagtacgtg tgctgttaat tatactaaag caccggatct aatgctgaac    3660

acatcgacac ccaaccttcc tgatttcaag gaagaattgt atcaatggtt taaaaaccaa    3720

tcttcattgg caccagattt gtcatttgat tatattaatg ttacgttctt ggacctacaa    3780

gatgaaatga ataggttaca agaagctata aaagttctaa atcatagcta catcaatctc    3840

aaggacattg gtacatatga gtattatgtg aaatggcctt ggtatgtatg gcttttaatt    3900

tgccttgctg gtgtagttat gcttgtttta ctattcttca tatgctgctg tacaggatgt    3960

gggactagtt gttttaagaa atgtggcggt tgtttttgatg attatactgg acaccaggag   4020

tttgtaatca aaacttcaca tgacgattaa tttcgt                               4056
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<210> 17
<211> 1363
<212> PRT
<213> bovine coronavirus strain LY138

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Met Phe Leu Ile Leu Leu Ile Ser Leu Pro Met Ala Leu Ala Val Ile
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Gly Asp Leu Lys Cys Thr Thr Val Ser Ile Asn Asp Val Asp Thr Gly
                20   25   30

Val Pro Ser Val Ser Thr Asp Thr Val Asp Val Thr Asn Gly Leu Gly
            35   40   45

Thr Tyr Tyr Val Leu Asp Arg Val Tyr Leu Asn Thr Thr Leu Leu Leu
    50   55   60

Asn Gly Tyr Tyr Pro Thr Ser Gly Ser Thr Tyr Arg Asn Met Ala Leu
65   70   75   80

Lys Gly Thr Leu Leu Leu Ser Thr Leu Trp Phe Lys Pro Pro Phe Leu
                85   90   95

Ser Asp Phe Ile Asn Gly Ile Phe Ala Lys Val Lys Asn Thr Lys Val
            100   105   110

Ile Lys Asn Gly Val Met Tyr Ser Glu Phe Pro Ala Ile Thr Ile Gly
            115   120   125

Ser Thr Phe Val Asn Thr Ser Tyr Ser Val Val Val Gln Pro His Thr
    130   135   140

Thr Asn Leu Asp Asn Lys Leu Gln Gly Leu Leu Glu Ile Ser Val Cys
145   150   155   160

Gln Tyr Thr Met Cys Glu Tyr Pro His Thr Ile Cys His Pro Asn Leu
                165   170   175

Gly Asn Arg Arg Ile Glu Leu Trp His Trp Asp Thr Gly Val Val Ser
            180   185   190

Cys Leu Tyr Lys Arg Asn Phe Thr Tyr Asp Val Asn Ala Asp Tyr Leu
        195   200   205

Tyr Phe His Phe Tyr Gln Glu Gly Gly Thr Phe Tyr Ala Tyr Phe Thr
    210   215   220

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Asp Thr Gly Val Val Thr Lys Phe Leu Phe Asn Val Tyr Leu Gly Thr
225                 230                 235                 240

Val Leu Ser His Tyr Tyr Val Met Pro Leu Thr Cys Asn Ser Ala Met
                245                 250                 255

Thr Leu Glu Tyr Trp Val Thr Pro Leu Thr Ser Lys Gln Tyr Leu Leu
            260                 265                 270

Ala Phe Asn Gln Asp Gly Val Ile Phe Asn Ala Val Asp Cys Lys Ser
            275                 280                 285

Asp Phe Met Ser Glu Ile Lys Cys Lys Thr Leu Ser Ile Ala Pro Ser
        290                 295                 300

Thr Gly Val Tyr Glu Leu Asn Gly Tyr Thr Val Gln Pro Ile Ala Asp
305                 310                 315                 320

Val Tyr Arg Arg Ile Pro Asn Leu Pro Asp Cys Asn Ile Glu Ala Trp
                325                 330                 335

Leu Asn Asp Lys Ser Val Pro Ser Pro Leu Asn Trp Glu Arg Lys Thr
            340                 345                 350

Phe Ser Asn Cys Asn Phe Asn Met Ser Ser Leu Met Ser Phe Ile Gln
        355                 360                 365

Ala Asp Ser Phe Thr Cys Asn Asn Ile Asp Ala Ala Lys Ile Tyr Gly
    370                 375                 380

Met Cys Phe Ser Ser Ile Thr Ile Asp Lys Phe Ala Ile Pro Asn Gly
385                 390                 395                 400

Arg Lys Val Asp Leu Gln Leu Gly Asn Leu Gly Tyr Leu Gln Ser Phe
                405                 410                 415

Asn Tyr Arg Ile Asp Thr Thr Ala Thr Ser Cys Gln Leu Tyr Tyr Asn
            420                 425                 430

Leu Pro Ala Ala Asn Val Ser Val Ser Arg Phe Asn Pro Ser Thr Trp
        435                 440                 445

Asn Arg Arg Phe Gly Phe Thr Glu Gln Ser Val Phe Lys Pro Gln Pro
    450                 455                 460

Val Gly Val Phe Thr Asp His Asp Val Val Tyr Ala Gln His Cys Phe
465                 470                 475                 480
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Lys Ala Pro Thr Asn Phe Cys Pro Cys Lys Leu Asp Gly Ser Leu Cys
            485   490   495

Val Gly Ser Gly Ser Gly Ile Asp Ala Gly Tyr Lys Asn Ser Gly Ile
            500   505   510

Gly Thr Cys Pro Ala Gly Thr Asn Tyr Leu Thr Cys His Asn Ala Ala
        515   520   525

Gln Cys Asn Cys Leu Cys Thr Pro Asp Pro Ile Thr Ser Lys Ser Thr
    530   535   540

Gly Pro Tyr Lys Cys Pro Gln Thr Lys Tyr Leu Val Gly Ile Gly Glu
545   550   555   560

His Cys Ser Gly Leu Ala Ile Lys Ser Asp Tyr Cys Gly Gly Asn Pro
            565   570   575

Cys Thr Cys Gln Pro Gln Ala Phe Leu Gly Trp Ser Val Asp Ser Cys
        580   585   590

Leu Gln Gly Asp Arg Cys Asn Ile Phe Ala Asn Phe Ile Leu His Asp
        595   600   605

Val Asn Ser Gly Thr Thr Cys Ser Thr Asp Leu Gln Lys Ser Asn Thr
    610   615   620

Asp Ile Ile Leu Gly Val Cys Val Asn Tyr Asp Leu Tyr Gly Ile Thr
625   630   635   640

Gly Gln Gly Ile Phe Val Glu Val Asn Ala Thr Tyr Tyr Asn Ser Trp
            645   650   655

Gln Asn Leu Leu Tyr Asp Ser Asn Gly Asn Leu Tyr Gly Phe Arg Asp
        660   665   670

Tyr Leu Thr Asn Arg Thr Phe Met Ile Arg Ser Cys Tyr Ser Gly Arg
        675   680   685

Val Ser Ala Ala Phe His Ala Asn Ser Ser Glu Pro Ala Leu Leu Phe
    690   695   700

Arg Asn Ile Lys Cys Asn Tyr Val Phe Asn Asn Thr Leu Ser Arg Gln
705   710   715   720

Leu Gln Pro Ile Asn Tyr Phe Asp Ser Tyr Leu Gly Cys Val Val Asn
            725   730   735

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Ala Asp Asn Ser Thr Ser Ser Ala Val Gln Thr Cys Asp Leu Thr Val
            740                 745                 750

Gly Ser Gly Tyr Cys Val Asp Tyr Ser Thr Lys Arg Arg Ser Arg Arg
            755                 760                 765

Ala Ile Thr Thr Gly Tyr Arg Phe Thr Asn Phe Glu Pro Phe Thr Val
    770                 775                 780

Asn Ser Val Asn Asp Ser Leu Glu Pro Val Gly Gly Leu Tyr Glu Ile
785                 790                 795                 800

Gln Ile Pro Ser Glu Phe Thr Ile Gly Asn Met Glu Glu Phe Ile Gln
                805                 810                 815

Ile Ser Ser Pro Lys Val Thr Ile Asp Cys Ser Ala Phe Val Cys Gly
            820                 825                 830

Asp Tyr Ala Ala Cys Lys Ser Gln Leu Val Glu Tyr Gly Ser Phe Cys
            835                 840                 845

Asp Asn Ile Asn Ala Ile Leu Thr Glu Val Asn Glu Leu Leu Asp Thr
    850                 855                 860

Thr Gln Leu Gln Val Ala Asn Ser Leu Met Asn Gly Val Thr Leu Ser
865                 870                 875                 880

Thr Lys Leu Lys Asp Gly Val Asn Phe Asn Val Asp Asp Ile Asn Phe
                885                 890                 895

Ser Pro Val Leu Gly Cys Leu Gly Ser Asp Cys Asn Lys Val Ser Ser
            900                 905                 910

Arg Ser Ala Ile Glu Asp Leu Leu Phe Ser Lys Val Lys Leu Ser Asp
            915                 920                 925

Val Gly Phe Val Glu Ala Tyr Asn Asn Cys Thr Gly Gly Ala Glu Ile
    930                 935                 940

Arg Asp Leu Ile Cys Val Gln Ser Tyr Asn Gly Ile Lys Val Leu Pro
945                 950                 955                 960

Pro Leu Leu Ser Glu Asn Gln Ile Ser Gly Tyr Thr Leu Ala Ala Thr
                965                 970                 975

Ser Ala Ser Leu Phe Pro Pro Trp Ser Ala Ala Ala Gly Val Pro Phe
            980                 985                 990
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Tyr Leu Asn Val Gln Tyr Arg Ile Asn Gly Ile Gly Val Thr Met Asp
        995   1000   1005

Val Leu Ser Gln Asn Gln Lys Leu Ile Ala Asn Ala Phe Asn Asn
    1010   1015   1020

Ala Leu Asp Ala Ile Gln Glu Gly Phe Asp Ala Thr Asn Ser Ala
    1025   1030   1035

Leu Val Lys Ile Gln Ala Val Val Asn Ala Asn Ala Glu Ala Leu
    1040   1045   1050

Asn Asn Leu Leu Gln Gln Leu Ser Asn Arg Phe Gly Ala Ile Ser
    1055   1060   1065

Ser Ser Leu Gln Glu Ile Leu Ser Arg Leu Asp Ala Leu Glu Ala
    1070   1075   1080

Gln Ala Gln Ile Asp Arg Leu Ile Asn Gly Arg Leu Thr Ala Leu
    1085   1090   1095

Asn Ala Tyr Val Ser Gln Gln Leu Ser Asp Ser Thr Leu Val Lys
    1100   1105   1110

Phe Ser Ala Ala Gln Ala Met Glu Lys Val Asn Glu Cys Val Lys
    1115   1120   1125

Ser Gln Ser Ser Arg Ile Asn Phe Cys Gly Asn Gly Asn His Ile
    1130   1135   1140

Ile Ser Leu Val Gln Asn Ala Pro Tyr Gly Leu Tyr Phe Ile His
    1145   1150   1155

Phe Ser Tyr Val Pro Thr Lys Tyr Val Thr Ala Lys Val Ser Pro
    1160   1165   1170

Gly Leu Cys Ile Ala Gly Asp Arg Gly Ile Ala Pro Lys Ser Gly
    1175   1180   1185

Tyr Phe Val Asn Val Asn Asn Thr Trp Met Phe Thr Gly Ser Gly
    1190   1195   1200

Tyr Tyr Tyr Pro Glu Pro Ile Thr Gly Asn Asn Val Val Val Met
    1205   1210   1215

Ser Thr Cys Ala Val Asn Tyr Thr Lys Ala Pro Asp Val Met Leu
    1220   1225   1230

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Asn Ile Ser Thr Pro Asn Leu Pro Asp Phe Lys Glu Glu Leu Asp
    1235   1240   1245

Gln Trp Phe Lys Asn Gln Thr Ser Val Ala Pro Asp Leu Ser Leu
    1250   1255   1260

Asp Tyr Ile Asn Val Thr Phe Leu Asp Leu Gln Asp Glu Met Asn
    1265   1270   1275

Arg Leu Gln Glu Ala Ile Lys Val Leu Asn Gln Ser Tyr Ile Asn
    1280   1285   1290

Leu Lys Asp Ile Gly Thr Tyr Glu Tyr Tyr Val Lys Trp Pro Trp
    1295   1300   1305

Tyr Val Trp Leu Leu Ile Gly Leu Ala Gly Val Ala Met Leu Val
    1310   1315   1320

Leu Leu Phe Phe Ile Cys Cys Cys Thr Gly Cys Gly Thr Ser Cys
    1325   1330   1335

Phe Lys Lys Cys Gly Gly Cys Cys Asp Asp Tyr Thr Gly His Gln
    1340   1345   1350

Glu Leu Val Ile Lys Thr Ser His Asp Asp
    1355   1360

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<213> human coronavirus strain OC43

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Met Phe Leu Ile Leu Leu Ile Ser Leu Pro Thr Ala Phe Ala Val Ile
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Gly Asp Leu Lys Cys Thr Thr Val Ser Ile Asn Asp Ile Asp Thr Gly
         20   25   30

Ala Pro Ser Ile Ser Thr Asp Ile Val Asp Val Thr Asn Gly Leu Gly
         35   40   45

Thr Tyr Tyr Val Leu Asp Arg Val Tyr Leu Asn Thr Thr Leu Leu Leu
         50   55   60

Asn Gly Tyr Tyr Pro Thr Ser Gly Ser Thr Tyr Arg Asn Met Ala Leu
65   70   75   80

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Lys Gly Thr Leu Leu Leu Ser Arg Leu Trp Phe Lys Pro Pro Phe Leu
            85                  90              95

Ser Asp Phe Ile Asn Gly Ile Phe Ala Lys Val Lys Asn Thr Lys Val
            100             105             110

Ile Lys Lys Gly Val Met Tyr Ser Glu Phe Pro Ala Ile Thr Ile Gly
        115             120             125

Ser Thr Phe Val Asn Thr Ser Tyr Ser Val Val Val Gln Pro His Thr
        130             135             140

Thr Asn Leu Asp Asn Lys Leu Gln Gly Leu Leu Glu Ile Ser Val Cys
145             150             155             160

Gln Tyr Thr Met Cys Glu Tyr Pro His Thr Ile Cys His Pro Asn Leu
            165             170             175

Gly Asn Arg Arg Val Glu Leu Trp His Trp Asp Thr Gly Val Val Ser
            180             185             190

Cys Leu Tyr Lys Arg Asn Phe Thr Tyr Asp Val Asn Ala Asp Tyr Leu
        195             200             205

Tyr Phe His Phe Tyr Gln Glu Gly Gly Thr Phe Tyr Ala Tyr Phe Thr
        210             215             220

Asp Thr Gly Val Val Thr Lys Phe Leu Phe Asn Val Tyr Leu Gly Thr
225             230             235             240

Val Leu Ser His Tyr Tyr Val Leu Pro Leu Thr Cys Asn Ser Ala Met
            245             250             255

Thr Leu Glu Tyr Trp Val Thr Pro Leu Thr Ser Lys Gln Tyr Leu Leu
            260             265             270

Ala Phe Asn Gln Asp Gly Val Ile Phe Asn Ala Val Asp Cys Lys Ser
        275             280             285

Asp Phe Met Ser Glu Ile Lys Cys Lys Thr Leu Ser Ile Ala Pro Ser
        290             295             300

Thr Gly Val Tyr Glu Leu Asn Gly Tyr Thr Val Gln Pro Ile Ala Asp
305             310             315             320

Val Tyr Arg Arg Ile Pro Asn Leu Pro Asp Cys Asn Ile Glu Ala Trp
            325             330             335
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Leu Asn Asp Lys Ser Val Pro Ser Pro Leu Asn Trp Glu Arg Lys Thr
            340             345             350

Phe Ser Asn Cys Asn Phe Asn Met Ser Ser Leu Met Ser Phe Ile Gln
            355             360             365

Ala Asp Ser Phe Thr Cys Asn Asn Ile Asp Ala Ala Lys Ile Tyr Gly
    370             375             380

Met Cys Phe Ser Ser Ile Thr Ile Asp Lys Phe Ala Ile Pro Asn Gly
385             390             395             400

Arg Lys Val Asp Leu Gln Leu Gly Asn Leu Gly Tyr Leu Gln Ser Phe
            405             410             415

Asn Tyr Arg Ile Asp Thr Thr Ala Thr Ser Cys Gln Leu Tyr Tyr Asn
            420             425             430

Leu Pro Ala Ala Asn Val Ser Val Ser Pro Phe Asn Pro Ser Thr Trp
            435             440             445

Asn Arg Arg Phe Gly Phe Thr Glu Gln Ser Val Phe Lys Pro Gln Pro
    450             455             460

Val Gly Val Phe Thr His His Asp Val Val Tyr Ala Gln His Cys Phe
465             470             475             480

Lys Ala Pro Thr Asn Phe Cys Pro Cys Lys Leu Asp Gly Ser Leu Cys
            485             490             495

Val Gly Asn Gly Pro Gly Ile Asp Ala Gly Tyr Lys Asn Ser Gly Ile
            500             505             510

Gly Thr Cys Pro Ala Gly Thr Asn Tyr Leu Thr Cys His Asn Ala Ala
            515             520             525

Gln Cys Asp Cys Leu Cys Thr Pro Asp Pro Ile Thr Ser Lys Ser Thr
            530             535             540

Gly Pro Tyr Lys Cys Pro Gln Thr Lys Tyr Leu Val Gly Ile Gly Glu
545             550             555             560

His Cys Ser Gly Leu Ala Ile Lys Ser Asp Tyr Cys Gly Gly Asn Pro
            565             570             575

Cys Thr Cys Gln Pro Gln Ala Phe Leu Gly Trp Ser Val Asp Ser Cys
            580             585             590
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Leu Gln Gly Asp Arg Cys Asn Ile Phe Ala Asn Phe Ile Leu His Asp
        595   600   605

Val Asn Ser Gly Thr Thr Cys Ser Thr Asp Leu Gln Lys Ser Asn Thr
        610   615   620

Asp Ile Ile Leu Gly Val Cys Val Asn Tyr Asp Leu Tyr Gly Ile Thr
625   630   635   640

Gly Gln Gly Ile Phe Val Glu Val Asn Ala Pro Tyr Tyr Asn Ser Trp
        645   650   655

Gln Asn Leu Leu Tyr Asp Ser Asn Gly Asn Leu Tyr Gly Phe Arg Asp
        660   665   670

Tyr Leu Thr Asn Arg Thr Phe Met Ile Arg Ser Cys Tyr Ser Gly Arg
        675   680   685

Val Ser Ala Ala Phe His Ala Asn Ser Ser Glu Pro Ala Leu Leu Phe
        690   695   700

Arg Asn Ile Lys Cys Ser Tyr Val Phe Asn Asn Thr Leu Ser Arg Gln
705   710   715   720

Leu Gln Pro Ile Asn Tyr Phe Asp Ser Tyr Leu Gly Cys Val Val Asn
        725   730   735

Ala Asp Asn Ser Thr Ser Ser Val Val Gln Thr Cys Asp Leu Thr Val
        740   745   750

Gly Ser Gly Tyr Cys Val Asp Tyr Ser Thr Lys Arg Arg Ser Arg Arg
        755   760   765

Ala Ile Thr Thr Gly Tyr Arg Phe Thr Asn Phe Glu Pro Phe Thr Val
        770   775   780

Asn Ser Val Asn Asp Ser Leu Glu Pro Val Gly Gly Leu Tyr Glu Ile
785   790   795   800

Gln Ile Pro Ser Glu Phe Thr Ile Gly Asn Met Glu Glu Phe Ile Gln
        805   810   815

Thr Ser Ser Pro Lys Val Thr Ile Asp Cys Ser Ala Phe Val Cys Gly
        820   825   830

Asp Tyr Ala Ala Cys Lys Ser Gln Leu Val Glu Tyr Gly Ser Phe Cys
        835   840   845

Asp Asn Ile Asn Ala Ile Leu Thr Glu Val Asn Glu Leu Leu Asp Thr
    850   855   860

Thr Gln Leu Gln Val Ala Asn Ser Leu Met Asn Gly Val Thr Leu Ser
865   870   875   880

Thr Lys Leu Lys Asp Gly Val Asn Phe Asn Val Asp Asp Ile Asn Phe
          885   890   895

Ser Pro Val Leu Gly Cys Leu Gly Ser Ala Cys Asn Lys Val Ser Ser
      900   905   910

Arg Ser Ala Ile Glu Asp Leu Leu Phe Ser Lys Val Lys Leu Ser Asp
      915   920   925

Val Gly Phe Val Glu Ala Tyr Asn Asn Cys Thr Gly Gly Ala Glu Ile
      930   935   940

Arg Asp Leu Ile Cys Val Gln Ser Tyr Asn Gly Ile Lys Val Leu Pro
945   950   955   960

Pro Leu Leu Ser Val Asn Gln Ile Ser Gly Tyr Thr Leu Ala Ala Thr
          965   970   975

Ser Ala Ser Leu Phe Pro Pro Trp Ser Ala Ala Ala Gly Val Pro Phe
      980   985   990

Tyr Leu Asn Val Gln Tyr Arg Ile Asn Gly Ile Gly Val Thr Met Asp
      995   1000   1005

Val Leu Ser Gln Asn Gln Lys Leu Ile Ala Asn Ala Phe Ser Asn
    1010   1015   1020

Ala Leu Asp Ala Ile Gln Glu Gly Phe Asp Ala Thr Asn Ser Ala
    1025   1030   1035

Leu Val Lys Ile Gln Ala Val Val Asn Ala Asn Ala Glu Ala Leu
    1040   1045   1050

Asn Asn Leu Leu Gln Gln Leu Ser Asn Arg Phe Gly Ala Ile Gly
    1055   1060   1065

Ser Ser Leu Gln Glu Ile Leu Ser Arg Leu Asp Ala Leu Glu Ala
    1070   1075   1080

Gln Ala Gln Ile Asp Arg Leu Ile Asn Gly Arg Leu Thr Ala Leu
    1085   1090   1095

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Asn Ala  Tyr Val Ser Gln Gln  Leu Ser Asp Ser Thr  Leu Val Lys
    1100             1105             1110

Phe Ser  Ala Ala Gln Ala Met  Glu Lys Val Asn Glu  Cys Val Lys
    1115             1120             1125

Ser Gln  Ser Ser Arg Ile Asn  Phe Cys Gly Asn Gly  Asn His Ile
    1130             1135             1140

Ile Ser  Leu Val Gln Asn Ala  Pro Tyr Gly Leu Tyr  Phe Ile His
    1145             1150             1155

Phe Ser  Tyr Val Pro Thr Lys  Tyr Val Thr Ala Lys  Val Ser Pro
    1160             1165             1170

Gly Leu  Cys Ile Ala Gly Asp  Arg Gly Ile Ala Pro  Lys Ser Gly
    1175             1180             1185

Tyr Phe  Val Asn Val Asn Asn  Thr Trp Met Phe Thr  Gly Ser Gly
    1190             1195             1200

Tyr Tyr  Tyr Pro Glu Pro Ile  Thr Gly Asn Asn Val  Val Val Met
    1205             1210             1215

Ser Thr  Cys Ala Val Asn Tyr  Thr Lys Ala Pro Asp  Val Met Leu
    1220             1225             1230

Asn Ile  Ser Thr Pro Asn Leu  His Asp Phe Lys Glu  Glu Leu Asp
    1235             1240             1245

Gln Trp  Phe Lys Asn Gln Thr  Ser Val Ala Pro Asp  Leu Ser Leu
    1250             1255             1260

Asp Tyr  Ile Asn Val Thr Phe  Leu Asp Leu Gln Asp  Glu Met Asn
    1265             1270             1275

Arg Leu  Gln Glu Ala Ile Lys  Val Leu Asn Gln Ser  Tyr Ile Asn
    1280             1285             1290

Leu Lys  Asp Ile Gly Thr Tyr  Glu Tyr Tyr Val Lys  Trp Pro Trp
    1295             1300             1305

Tyr Val  Trp Leu Leu Ile Gly  Phe Ala Gly Val Ala  Met Leu Val
    1310             1315             1320

Leu Leu  Phe Phe Ile Cys Cys  Cys Thr Gly Cys Gly  Thr Ser Cys
    1325             1330             1335
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Phe Lys Ile Cys Gly Gly Cys Cys Asp Asp Tyr Thr Gly His Gln
    1340   1345   1350

Glu Leu Val Ile Lys Thr Ser His Asp Asp
    1355   1360

<210> 19
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<212> PRT
<213> hemagglutinating encephalomyelitis virus

<400> 19

Met Phe Phe Ile Leu Leu Ile Thr Leu Pro Ser Val Phe Ala Val Ile
1   5   10   15

Gly Asp Leu Lys Cys Asn Thr Ser Ser Ile Asn Asp Val Asp Thr Gly
            20   25   30

Val Pro Ser Ile Ser Ser Glu Val Val Asp Val Thr Asn Gly Leu Gly
        35   40   45

Thr Phe Tyr Val Leu Asp Arg Val Tyr Leu Asn Thr Thr Leu Leu Leu
    50   55   60

Asn Gly Tyr Tyr Pro Ile Ser Gly Ala Thr Phe Arg Asn Val Ala Leu
65   70   75   80

Lys Gly Thr Arg Leu Leu Ser Thr Leu Trp Phe Lys Pro Pro Phe Leu
            85   90   95

Ser Pro Phe Asn Asp Gly Ile Phe Ala Lys Val Lys Asn Ser Arg Phe
            100   105   110

Ser Lys His Gly Val Ile Tyr Ser Glu Phe Pro Ala Ile Thr Ile Gly
    115   120   125

Ser Thr Phe Val Asn Thr Ser Tyr Ser Ile Val Val Lys Pro His Thr
    130   135   140

Ser Phe Ile Asn Gly Asn Leu Gln Gly Phe Leu Gln Ile Ser Val Cys
145   150   155   160

Gln Tyr Thr Met Cys Glu Tyr Pro Gln Thr Ile Cys His Pro Asn Leu
            165   170   175

Gly Asn Gln Arg Ile Glu Leu Trp His His Asp Thr Asp Val Val Ser
            180   185   190

Cys Leu Tyr Arg Arg Asn Phe Thr Tyr Asp Val Asn Ala Asp Tyr Leu
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          195                     200                     205
Tyr Phe His Phe Tyr Gln Glu Gly Gly Thr Phe Tyr Ala Tyr Phe Thr
    210                     215                     220

Asp Thr Gly Phe Val Thr Lys Phe Leu Phe Lys Leu Leu Gly Thr
225                     230                     235                     240

Val Leu Ser His Tyr Tyr Val Met Pro Leu Thr Cys Asp Ser Ala Leu
                    245                     250                     255

Ser Leu Glu Tyr Trp Val Thr Pro Leu Thr Thr Arg Gln Phe Leu Leu
              260                     265                     270

Ala Phe Asp Gln Asp Gly Val Leu Tyr His Ala Val Asp Cys Ala Ser
        275                     280                     285

Asp Phe Met Ser Glu Ile Met Cys Lys Thr Ser Ser Ile Thr Pro Pro
    290                     295                     300

Thr Gly Val Tyr Glu Leu Asn Gly Tyr Thr Val Gln Pro Val Ala Thr
305                     310                     315                     320

Val Tyr Arg Arg Ile Pro Asp Leu Pro Asn Cys Asp Ile Glu Ala Trp
              325                     330                     335

Leu Asn Ser Lys Thr Val Ser Ser Pro Leu Asn Trp Glu Arg Lys Ile
              340                     345                     350

Phe Ser Asn Cys Asn Phe Asn Met Gly Arg Leu Met Ser Phe Ile Gln
        355                     360                     365

Ala Asp Ser Phe Gly Cys Asn Asn Ile Asp Ala Ser Arg Leu Tyr Gly
    370                     375                     380

Met Cys Phe Gly Ser Ile Thr Ile Asp Lys Phe Ala Ile Pro Asn Ser
385                     390                     395                     400

Arg Lys Val Asp Leu Gln Val Gly Lys Ser Gly Tyr Leu Gln Ser Phe
              405                     410                     415

Asn Tyr Lys Ile Asp Thr Ala Val Ser Ser Cys Gln Leu Tyr Tyr Ser
        420                     425                     430

Leu Pro Ala Ala Asn Val Ser Val Thr His Tyr Asn Pro Ser Ser Trp
        435                     440                     445

Asn Arg Arg Tyr Gly Phe Ile Asn Gln Ser Phe Gly Ser Arg Gly Leu
```

```
         450                    455                    460

His Asp Ala Val Tyr Ser Gln Gln Cys Phe Asn Thr Pro Asn Thr Tyr
465                     470                    475                    480

Cys Pro Cys Arg Thr Ser Gln Cys Ile Gly Gly Ala Gly Thr Gly Thr
                        485                    490                    495

Cys Pro Val Gly Thr Thr Val Arg Lys Cys Phe Ala Ala Val Thr Asn
                        500                    505                    510

Ala Thr Lys Cys Thr Cys Trp Cys Gln Pro Asp Pro Ser Thr Tyr Lys
                        515                    520                    525

Gly Val Asn Ala Trp Thr Cys Pro Gln Ser Lys Val Ser Ile Gln Pro
                        530                    535                    540

Gly Gln His Cys Pro Gly Leu Gly Leu Val Glu Asp Asp Cys Ser Gly
545                     550                    555                    560

Asn Pro Cys Thr Cys Lys Pro Gln Ala Phe Ile Gly Trp Ser Ser Glu
                        565                    570                    575

Thr Cys Leu Gln Asn Gly Arg Cys Asn Ile Phe Ala Asn Phe Ile Leu
                        580                    585                    590

Asn Asp Val Asn Ser Gly Thr Thr Cys Ser Thr Asp Leu Gln Gln Gly
                        595                    600                    605

Asn Thr Asn Ile Thr Thr Asp Val Cys Val Asn Tyr Asp Leu Tyr Gly
                        610                    615                    620

Ile Thr Gly Gln Gly Ile Leu Ile Glu Val Asn Ala Thr Tyr Tyr Asn
625                     630                    635                    640

Ser Trp Gln Asn Leu Leu Tyr Asp Ser Ser Gly Asn Leu Tyr Gly Phe
                        645                    650                    655

Arg Asp Tyr Leu Ser Asn Arg Thr Phe Leu Ile Arg Ser Cys Tyr Ser
                        660                    665                    670

Gly Arg Val Ser Ala Val Phe His Ala Asn Ser Ser Glu Pro Ala Leu
                        675                    680                    685

Met Phe Arg Asn Leu Lys Cys Ser His Val Phe Asn Tyr Thr Ile Leu
        690                    695                    700

Arg Gln Ile Gln Leu Val Asn Tyr Phe Asp Ser Tyr Leu Gly Cys Val
```

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705   710   715   720

Val Asn Ala Tyr Asn Asn Thr Ala Ser Ala Val Ser Thr Cys Asp Leu
              725   730   735

Thr Val Gly Ser Gly Tyr Cys Val Asp Tyr Val Thr Ala Leu Arg Ser
              740   745   750

Arg Arg Ser Phe Thr Thr Gly Tyr Arg Phe Thr Asn Phe Glu Pro Phe
              755   760   765

Ala Ala Asn Leu Val Asn Asp Ser Ile Glu Pro Val Gly Gly Leu Tyr
      770   775   780

Glu Ile Gln Ile Pro Ser Glu Phe Thr Ile Gly Asn Leu Glu Glu Phe
785   790   795   800

Ile Gln Thr Ser Ser Pro Lys Val Thr Ile Asp Cys Ala Thr Phe Val
              805   810   815

Cys Gly Asp Tyr Ala Ala Cys Arg Gln Gln Leu Ala Glu Tyr Gly Ser
              820   825   830

Phe Cys Glu Asn Ile Asn Ala Ile Leu Ile Glu Val Asn Glu Leu Leu
              835   840   845

Asp Thr Thr Gln Leu Gln Val Ala Asn Ser Leu Met Asn Gly Val Thr
      850   855   860

Leu Ser Thr Lys Ile Lys Asp Gly Ile Asn Phe Asn Val Asp Asp Ile
865   870   875   880

Asn Phe Ser Ser Val Leu Gly Cys Leu Gly Ser Glu Cys Asn Arg Ala
              885   890   895

Ser Thr Arg Ser Ala Ile Glu Asp Leu Leu Phe Asp Lys Val Lys Leu
              900   905   910

Ser Asp Val Gly Phe Val Gln Ala Tyr Asn Asn Cys Thr Gly Gly Ala
              915   920   925

Glu Ile Arg Asp Leu Ile Cys Val Gln Ser Tyr Asn Gly Ile Lys Val
      930   935   940

Leu Pro Pro Leu Leu Ser Glu Asn Gln Ile Ser Gly Tyr Thr Ser Ala
945   950   955   960

Ala Thr Ala Ala Ser Leu Phe Pro Pro Trp Thr Ala Ala Ala Gly Val

Pro Phe Tyr Leu Asn Val Gln Tyr Arg Ile Asn Gly Leu Gly Val Thr
        980   985   990

Met Asp Val Leu Ser Gln Asn Gln Lys Leu Ile Ala Ser Ala Phe Asn
        995   1000   1005

Asn Ala Leu Asp Ser Ile Gln Glu Gly Phe Asp Ala Thr Asn Ser
    1010   1015   1020

Ala Leu Val Lys Ile Gln Ala Val Val Asn Ala Asn Ala Glu Ala
    1025   1030   1035

Leu Asn Asn Leu Leu Gln Gln Leu Ser Asn Arg Phe Gly Ala Ile
    1040   1045   1050

Ser Ala Ser Leu Gln Glu Ile Leu Ser Arg Leu Asp Ala Leu Glu
    1055   1060   1065

Ala Lys Ala Gln Ile Asp Arg Leu Ile Asn Gly Arg Leu Thr Ala
    1070   1075   1080

Leu Asn Ala Tyr Val Ser Gln Gln Leu Ser Asp Ser Thr Leu Val
    1085   1090   1095

Lys Phe Ser Ala Ala Gln Ala Ile Glu Lys Val Asn Glu Cys Val
    1100   1105   1110

Lys Ser Gln Ser Ser Arg Ile Asn Phe Cys Gly Asn Gly Asn His
    1115   1120   1125

Ile Ile Ser Leu Val Gln Asn Ala Pro Tyr Gly Leu Tyr Phe Ile
    1130   1135   1140

His Phe Ser Tyr Val Pro Thr Lys Tyr Val Thr Ala Lys Val Ser
    1145   1150   1155

Pro Gly Leu Cys Ile Ala Gly Asp Ile Gly Ile Ser Pro Lys Ser
    1160   1165   1170

Gly Tyr Phe Ile Asn Val Asn Asn Ser Trp Met Phe Thr Gly Ser
    1175   1180   1185

Gly Tyr Tyr Tyr Pro Glu Pro Ile Thr Gln Asn Asn Val Val Val
    1190   1195   1200

Met Ser Thr Cys Ala Val Asn Tyr Thr Lys Ala Pro Asp Leu Met

```
                           1205                     1210                    1215

Leu Asn  Thr Ser Thr Pro Asn  Leu Pro Asp Phe Lys  Glu Glu Leu
         1220                  1225                 1230

Tyr Gln  Trp Phe Lys Asn Gln  Ser Ser Leu Ala Pro  Asp Leu Ser
         1235                  1240                 1245

Phe Asp  Tyr Ile Asn Val Thr  Phe Leu Asp Leu Gln  Asp Glu Met
         1250                  1255                 1260

Asn Arg  Leu Gln Glu Ala Ile  Lys Val Leu Asn His  Ser Tyr Ile
         1265                  1270                 1275

Asn Leu  Lys Asp Ile Gly Thr  Tyr Glu Tyr Tyr Val  Lys Trp Pro
         1280                  1285                 1290

Trp Tyr  Val Trp Leu Leu Ile  Cys Leu Ala Gly Val  Val Met Leu
         1295                  1300                 1305

Val Leu  Leu Phe Phe Ile Cys  Cys Cys Thr Gly Cys  Gly Thr Ser
         1310                  1315                 1320

Cys Phe  Lys Lys Cys Gly Gly  Cys Phe Asp Asp Tyr  Thr Gly His
         1325                  1330                 1335

Gln Glu  Phe Val Ile Lys Thr  Ser His Asp Asp
         1340                  1345
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<210> 20
<211> 1453
<212> PRT
<213> canine enteric coronavirus

<400> 20

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Met Ile Val Leu Val Thr Cys Ile Leu Leu Leu Cys Ser Tyr His Thr
1               5                   10                  15

Ala Ser Ser Thr Ser Asn Asn Asp Cys Arg Gln Val Asn Val Thr Gln
                20                  25                  30

Leu Asp Gly Asn Glu Asn Leu Ile Arg Asp Phe Leu Phe Gln Asn Phe
            35                  40                  45

Lys Glu Glu Gly Thr Val Val Gly Gly Tyr Tyr Pro Thr Glu Val
     50                  55                  60

Trp Tyr Asn Cys Ser Arg Thr Ala Thr Thr Thr Ala Tyr Glu Tyr Phe
65                  70                  75                  80
```

```
Ser Asn Ile His Ala Phe Tyr Phe Asp Met Glu Ala Met Glu Asn Ser
                85                  90                  95

Thr Gly Asn Ala Arg Gly Lys Pro Leu Leu Phe His Val His Gly Glu
            100             105                 110

Pro Val Ser Val Ile Ile Tyr Ile Ser Tyr Arg Asp Asp Val Gln His
            115             120                 125

Arg Pro Leu Leu Lys His Gly Leu Val Cys Ile Thr Glu Ser Arg Asn
        130             135                 140

Ile Asp Tyr Asn Ser Phe Thr Ser Ser Gln Trp Asn Ser Ile Cys Thr
145                 150                 155                 160

Gly Asn Asp Arg Lys Ile Pro Phe Ser Val Ile Pro Thr Asp Asn Gly
            165                 170                 175

Thr Lys Ile Tyr Gly Leu Glu Trp Asn Asp Glu Phe Val Thr Ala Tyr
            180                 185                 190

Ile Ser Gly Arg Ser Tyr Asn Trp Asn Ile Asn Asn Asn Trp Phe Asn
            195             200                 205

Asn Val Thr Leu Leu Tyr Ser Arg Ser Thr Ala Thr Trp Gln His
        210             215             220

Ser Ala Ala Tyr Val Tyr Gln Gly Val Ser Asn Phe Thr Tyr Tyr Lys
225                 230             235                 240

Leu Asn Asn Thr Asn Gly Leu Lys Thr Tyr Glu Leu Cys Glu Asp Tyr
            245             250             255

Glu Tyr Cys Thr Gly Tyr Ala Thr Asn Ile Phe Ala Pro Thr Val Gly
            260             265             270

Gly Tyr Ile Pro Asp Gly Phe Ser Phe Asn Asn Trp Phe Leu Leu Thr
            275             280             285

Asn Ser Ser Thr Phe Val Ser Gly Arg Phe Val Thr Asn Gln Pro Leu
        290             295             300

Leu Val Asn Cys Leu Trp Pro Val Pro Ser Phe Gly Val Ala Ala Gln
305             310             315             320

Glu Phe Cys Phe Glu Gly Ala Gln Phe Ser Gln Cys Asn Gly Val Phe
            325             330             335
```

Leu Asn Asn Thr Val Asp Val Ile Arg Phe Asn Leu Asn Phe Thr Ala
          340   345   350

Asp Val Gln Ser Gly Met Gly Ala Thr Val Phe Ser Leu Asn Thr Thr
          355   360   365

Gly Gly Cys Ile Leu Glu Ile Ser Cys Tyr Asn Asp Ile Val Ser Glu
          370   375   380

Ser Ser Phe Tyr Ser Tyr Gly Glu Ile Pro Phe Gly Val Thr Asp Gly
385   390   395   400

Pro Arg Tyr Cys Tyr Val Leu Tyr Asn Gly Thr Ala Leu Lys Tyr Phe
          405   410   415

Gly Thr Leu Pro Pro Ser Val Lys Glu Ile Ala Ile Ser Lys Trp Gly
          420   425   430

Gln Phe Tyr Ile Asn Gly Tyr Asn Phe Phe Ser Thr Phe Pro Ile Asp
          435   440   445

Cys Ile Ser Phe Asn Leu Thr Thr Gly Asp Ser Gly Ala Phe Trp Thr
          450   455   460

Ile Ala Tyr Thr Ser Tyr Thr Glu Ala Leu Val Gln Val Glu Asn Thr
465   470   475   480

Ala Ile Lys Lys Val Thr Tyr Cys Asn Ser His Ile Asn Asn Ile Lys
          485   490   495

Cys Ser Gln Leu Thr Ala Asn Leu Gln Asn Gly Phe Tyr Pro Val Ala
          500   505   510

Ser Ser Glu Val Gly Leu Val Asn Lys Ser Val Val Leu Leu Pro Ser
          515   520   525

Phe Tyr Ser His Thr Ser Val Asn Ile Thr Ile Asp Leu Gly Met Lys
          530   535   540

Arg Ser Gly Tyr Gly Gln Pro Ile Ala Ser Thr Leu Ser Asn Ile Thr
545   550   555   560

Leu Pro Met Gln Asp Asn Asn Thr Asp Val Tyr Cys Ile Arg Ser Asn
          565   570   575

Gln Phe Ser Val Tyr Val His Ser Thr Cys Lys Ser Ser Leu Trp Asp
          580   585   590

```
Asn Asn Phe Asn Gln Asp Cys Thr Asp Val Leu Tyr Ala Thr Ala Val
        595             600                 605

Ile Lys Thr Gly Thr Cys Pro Phe Ser Phe Asp Lys Leu Asn Asn Tyr
        610             615                 620

Leu Thr Phe Asn Lys Leu Cys Leu Ser Leu Asn Pro Thr Gly Ala Asn
625             630                 635                 640

Cys Lys Phe Asp Val Ala Ala Arg Thr Arg Thr Asn Glu Gln Val Val
                645                 650                 655

Arg Ser Leu Tyr Val Ile Tyr Glu Glu Gly Asp Asn Ile Val Gly Val
        660                 665                 670

Pro Ser Asp Asn Ser Gly Leu His Asp Leu Ser Val Leu His Leu Asp
        675                 680                 685

Ser Cys Thr Asp Tyr Asn Ile Tyr Gly Arg Thr Gly Val Gly Ile Ile
        690                 695                 700

Arg Gln Thr Asn Ser Thr Ile Leu Ser Gly Leu His Tyr Thr Ser Leu
705             710                 715                 720

Ser Gly Asp Leu Leu Gly Phe Lys Asn Val Ser Asp Gly Val Val Tyr
                725                 730                 735

Ser Val Thr Pro Cys Asp Val Ser Ala Gln Ala Ala Val Ile Asp Gly
        740                 745                 750

Ala Ile Val Gly Ala Met Thr Ser Ile Asn Ser Glu Leu Leu Gly Leu
        755                 760                 765

Thr His Trp Thr Thr Thr Pro Asn Phe Tyr Tyr Tyr Ser Ile Tyr Asn
        770                 775                 780

Thr Thr Asn Glu Arg Thr Arg Gly Thr Ala Ile Asp Ser Asn Asp Val
785             790                 795                 800

Asp Cys Glu Pro Ile Ile Thr Tyr Ser Asn Ile Gly Val Cys Lys Asn
                805                 810                 815

Gly Ala Leu Val Phe Ile Asn Val Thr His Ser Asp Gly Asp Val Gln
        820                 825                 830

Pro Ile Ser Thr Gly Asn Val Thr Ile Pro Thr Asn Phe Thr Ile Ser
        835                 840                 845
```

Val Gln Val Glu Tyr Ile Gln Val Tyr Thr Thr Pro Val Ser Ile Asp
    850   855   860

Cys Ser Arg Tyr Val Cys Asn Gly Asn Pro Arg Cys Asn Lys Leu Leu
865   870   875   880

Thr Gln Tyr Val Ser Ala Cys Gln Thr Ile Glu Gln Ala Leu Ala Met
            885   890   895

Ser Ala Ser Leu Glu Asn Met Glu Val Asp Ser Met Leu Phe Val Ser
        900   905   910

Glu Asn Ala Leu Lys Leu Ala Ser Val Glu Ala Phe Asn Ser Thr Glu
    915   920   925

His Leu Asp Pro Ile Tyr Lys Glu Trp Pro Asn Ile Gly Gly Ser Trp
    930   935   940

Leu Gly Gly Leu Lys Asp Ile Leu Pro Ser His Asn Ser Lys Arg Lys
945   950   955   960

Tyr Arg Ser Ala Ile Glu Asp Leu Leu Phe Asp Lys Val Val Thr Ser
            965   970   975

Gly Leu Gly Thr Val Asp Glu Asp Tyr Lys Arg Cys Thr Gly Gly Tyr
        980   985   990

Asp Ile Ala Asp Leu Val Cys Ala Gln Tyr Tyr Asn Gly Ile Met Val
        995   1000   1005

Leu Pro Gly Val Ala Asn Asp Asp Lys Met Thr Met Tyr Thr Ala
    1010   1015   1020

Ser Leu Ala Gly Gly Ile Ala Leu Gly Ala Leu Gly Gly Gly Ala
    1025   1030   1035

Val Ala Ile Pro Phe Ala Val Ala Val Gln Ala Arg Leu Asn Tyr
    1040   1045   1050

Val Ala Leu Gln Thr Asp Val Leu Asn Lys Asn Gln Gln Ile Leu
    1055   1060   1065

Ala Asn Ala Phe Asn Gln Ala Ile Gly Asn Ile Thr Gln Ala Phe
    1070   1075   1080

Gly Lys Val Asn Asp Ala Ile His Gln Thr Ser Gln Gly Leu Ala
    1085   1090   1095

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```
Thr Val  Ala Lys Ala Leu Ala  Lys Val Gln Asp Val  Val Asn Thr
    1100              1105              1110

Gln Gly  Gln Ala Leu Ser His  Leu Thr Val Gln Leu  Gln Asn Ser
    1115              1120              1125

Phe Gln  Ala Ile Ser Ser Ser  Ile Ser Asp Ile Tyr  Asn Arg Leu
    1130              1135              1140

Asp Glu  Leu Ser Ala Asp Ala  Gln Val Asp Arg Leu  Ile Thr Gly
    1145              1150              1155

Arg Leu  Thr Ala Leu Asn Ala  Phe Val Ser Gln Thr  Leu Thr Arg
    1160              1165              1170

Gln Ala  Glu Val Arg Ala Ser  Arg Gln Leu Ala Lys  Asp Lys Val
    1175              1180              1185

Asn Glu  Cys Val Arg Ser Gln  Ser Gln Arg Phe Gly  Phe Cys Gly
    1190              .1195              1200

Asn Gly  Thr His Leu Phe Ser  Leu Ala Asn Ala Ala  Pro Asn Gly
    1205              1210              1215

Met Val  Phe Phe His Thr Val  Leu Leu Pro Thr Ala  Tyr Glu Thr
    1220              1225              1230

Val Thr  Ala Trp Ser Gly Ile  Cys Ala Ser Asp Gly  Asp Arg Thr
    1235              1240              1245

Phe Gly  Leu Val Val Lys Asp  Val Gln Leu Thr Leu  Phe Arg Asn
    1250              1255              1260

Leu Asp  Asp Lys Phe Tyr Leu  Thr Pro Arg Thr Met  Tyr Gln Pro
    1265              1270              1275

Arg Ala  Ala Thr Ser Ser Asp  Phe Val Gln Ile Glu  Gly Cys Asp
    1280              1285              1290

Val Leu  Phe Val Asn Ala Thr  Val Ile Asp Leu Pro  Ser Ile Ile
    1295              1300              1305

Pro Asp  Tyr Ile Asp Ile Asn  Gln Thr Val Gln Asp  Ile Leu Glu
    1310              1315              1320

Asn Tyr  Arg Pro Asn Trp Thr  Val Pro Glu Leu Thr  Ile Asp Ile
    1325              1330              1335
```

```
Phe Asn  Ala Thr Tyr Leu Asn  Leu Thr Gly Glu Ile  Asp Asp Leu
    1340                 1345                 1350

Glu Phe  Arg Ser Glu Lys Leu  His Asn Thr Thr Val  Glu Leu Ala
    1355                 1360                 1365

Ile Leu  Ile Asp Asn Ile Asn  Asn Thr Leu Val Asn  Leu Glu Trp
    1370                 1375                 1380

Leu Asn  Arg Ile Glu Thr Tyr  Val Lys Trp Pro Trp  Tyr Val Trp
    1385                 1390                 1395

Leu Leu  Ile Gly Leu Val Ala  Val Phe Cys Ile Pro  Leu Leu Leu
    1400                 1405                 1410

Phe Cys  Cys Cys Ser Thr Gly  Cys Cys Gly Cys Ile  Gly Cys Leu
    1415                 1420                 1425

Gly Ser  Cys Cys His Ser Ile  Cys Ser Arg Arg Gln  Phe Glu Asn
    1430                 1435                 1440

Tyr Glu  Pro Ile Glu Lys Val  His Val His
    1445                 1450
```

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<210>  21
<211>  496
<212>  DNA
<213>  canine respiratory coronavirus

<400>  21
tatcgcagcc ttacttttgt taatgtacca tatgtttata atggctctgc acaatctaca      60
gctctttgta aatctggtag tttagttctt aataaccctg catatatagc tcgtgaagct     120
aatttttggg attattatta taaggttgaa gctgatttct atttgtcagg ttgtgacgag     180
tatatcgtac cactttgtat ttttaacggc aagtttttgt cgaatacaaa gtattatgat     240
gatagtcaat attattttaa taaagacact ggtgttattt atggtttcaa ttctactgaa     300
accattaaca ctggtttttga ttttaattgt cattatttac ttttaccctc tggtaattat     360
ttagccattt caaatgagct attgttaact gttcctacga aagcaatctg tcttaataag     420
cgtaaggatt ttacgcctgt acaggttgtt gactcgcggt ggaacaatgc caggcagtct     480
gataacatga cggcgg                                                     496
```

```
<210>  22
<211>  165
<212>  PRT
<213>  canine respiratory coronavirus
```

<400> 22

```
Tyr Arg Ser Leu Thr Phe Val Asn Val Pro Tyr Val Tyr Asn Gly Ser
1               5                   10                  15

Ala Gln Ser Thr Ala Leu Cys Lys Ser Gly Ser Leu Val Leu Asn Asn
            20                  25                  30

Pro Ala Tyr Ile Ala Arg Glu Ala Asn Phe Gly Asp Tyr Tyr Tyr Lys
            35                  40                  45

Val Glu Ala Asp Phe Tyr Leu Ser Gly Cys Asp Glu Tyr Ile Val Pro
        50                  55                  60

Leu Cys Ile Phe Asn Gly Lys Phe Leu Ser Asn Thr Lys Tyr Tyr Asp
65                  70                  75                  80

Asp Ser Gln Tyr Tyr Phe Asn Lys Asp Thr Gly Val Ile Tyr Gly Phe
            85                  90                  95

Asn Ser Thr Glu Thr Ile Asn Thr Gly Phe Asp Phe Asn Cys His Tyr
            100                 105                 110

Leu Leu Leu Pro Ser Gly Asn Tyr Leu Ala Ile Ser Asn Glu Leu Leu
        115                 120                 125

Leu Thr Val Pro Thr Lys Ala Ile Cys Leu Asn Lys Arg Lys Asp Phe
        130                 135                 140

Thr Pro Val Gln Val Val Asp Ser Arg Trp Asn Asn Ala Arg Gln Ser
145                 150                 155                 160

Asp Asn Met Thr Ala
            165
```

<210> 23
<211> 497
<212> DNA
<213> bovine coronavirus strain LY138

<400> 23
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tatcgcagcc ttacttttgt taatgtacca tatgtttata atggctctgc acaatctaca    60

gctctttgta aatctggtag tttagttctt aataaccctg catatatagc tcgtgaagct   120

aattttgggg attattatta taaggttgaa gctgattttt atttgtcagg ttgtgacgag   180

tatatcgtac cactttgtat ttttaacggc aagtttttgt cgaatacaaa gtattatgat   240

gatagtcaat attattttaa taaagacact ggtgttattt atggtctcaa ttctactgaa   300

accattacca ctggttttga ttttaattgt cattatttag ttttaccctc tggtaattat   360
```

```
ttagccattt caaatgagct attgttaact gttcctacga aagcaatctg tcttaataag    420

cgtaaggatt ttacgcctgt acaggttgtt gactctcgat ggaacaatgc caggcagtct    480

gataacatga cggcggt                                                   497
```

```
<210>  24
<211>  497
<212>  DNA
<213>  human coronavirus strain OC43
```

```
<400>  24
tatcgcagcc ttacttttgt taatgtacca tatgtttata atggctctgc acaatctaca     60

gctctttgta aatctggtag tttagtcctt aataaccctg catatatagc tcctcaagct    120

aactctgggg attattatta taaggttgaa gctgattttt atttgtcagg ttgtgacgag    180

tatatcgtac cactttgtat ttttaacggc aagtttttgt cgaatacaaa gtattatgat    240

gatagtcaat attattttaa taaagacact ggtgttattt atggtctcaa ttctacagaa    300

accattacca ctggttttga tcttaattgt tattatttag ttttaccctc tggtaattat    360

ttagccattt caaatgagct attgttaact gttcctacga aagcaatctg tcttaataag    420

cgtaaggatt ttacgcctgt acaggttgtt gattcgcggt ggaacaatgc caggcagtct    480

gataacatga cggcggt                                                   497
```

```
<210>  25
<211>  497
<212>  DNA
<213>  human enteric coronavirus
```

```
<400>  25
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gctctttgta aatctggtag tttagttctt aataaccctg catatatagc tcgtgaagct    120

aattttgggg attattatta taaggttgaa gctgattttt atttgtcagg ttgtgacgag    180

tatatcgtac cactttgtat ttttaacggc aagtttttgt cgaatacaaa gtattatgat    240

gatagtcaat attattttaa taaagacact ggtgttattt atggtctcaa ttctactgaa    300

accattacca ctggttttga ttttaattgt cattatttag ttctaccctc tggcaattat    360

ttagccattt caaatgagct attgttaact gttcctacta aagcaatctg tcttaataag    420

cgtaaggatt ttacgcctgt acaggttgtt gactcgcggt ggaacaatgc caggcagtct    480

gataacatga cggcagt                                                   497
```

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<210>  26
<211>  497
<212>  DNA
<213>  hemagglutinating encephalomyelitis virus
```

```
<400>  26
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```

```
gcactttgta agtctggcag tttaattctt aacaatcctg catatatagc ccgtgaggct    120

aatgtgggtg attattatta taagtctgaa gcagattttt ctctctcagg ttgtgacgag    180

tatatcgtac cactttgtat ttttaatggc aagtttttgt cgaatacaaa gtattatgat    240

gatagtcaat attattttaa taaagacact ggtgttattt atggtctcaa ttctactgaa    300

accattacca ctggtttttga ttttaattgt cattatttag ttctaccctc tggtaattat    360

ctagccattt caaatgagct attgttaact gttcctacta aagcaatctg tcttaataag    420

cgtaaggttt ttacgcctgt acaggttgtt gattcgcggt ggaacaatgc caggcaatct    480

gataacatga cggcagt                                                   497
```

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<210>  27
<211>  165
<212>  PRT
<213>  bovine coronavirus strain LY138

<400>  27

Tyr Arg Ser Leu Thr Phe Val Asn Val Pro Tyr Val Tyr Asn Gly Ser
1               5                   10                  15


Ala Gln Ser Thr Ala Leu Cys Lys Ser Gly Ser Leu Val Leu Asn Asn
                20                  25                  30


Pro Ala Tyr Ile Ala Arg Glu Ala Asn Phe Gly Asp Tyr Tyr Tyr Lys
        35                  40                  45


Val Glu Ala Asp Phe Tyr Leu Ser Gly Cys Asp Glu Tyr Ile Val Pro
    50                  55                  60


Leu Cys Ile Phe Asn Gly Lys Phe Leu Ser Asn Thr Lys Tyr Tyr Asp
65                  70                  75                  80


Asp Ser Gln Tyr Tyr Asn Lys Asp Thr Gly Val Ile Tyr Gly Leu
                85                  90                  95


Asn Ser Thr Glu Thr Ile Thr Thr Gly Phe Asp Phe Asn Cys His Tyr
                100                 105                 110


Leu Val Leu Pro Ser Gly Asn Tyr Leu Ala Ile Ser Asn Glu Leu Leu
            115                 120                 125


Leu Thr Val Pro Thr Lys Ala Ile Cys Leu Asn Lys Arg Lys Asp Phe
        130                 135                 140


Thr Pro Val Gln Val Val Asp Ser Arg Trp Asn Asn Ala Arg Gln Ser
145                 150                 155                 160
```

Asp Asn Met Thr Ala
                   165

<210> 28
<211> 165
<212> PRT
<213> human coronavirus strain OC43

<400> 28

Tyr Arg Ser Leu Thr Phe Val Asn Val Pro Tyr Val Tyr Asn Gly Ser
1   5   10   15

Ala Gln Ser Thr Ala Leu Cys Lys Ser Gly Ser Leu Val Leu Asn Asn
                20   25   30

Pro Ala Tyr Ile Ala Pro Gln Ala Asn Ser Gly Asp Tyr Tyr Tyr Lys
            35   40   45

Val Glu Ala Asp Phe Tyr Leu Ser Gly Cys Asp Glu Tyr Ile Val Pro
    50   55   60

Leu Cys Ile Phe Asn Gly Lys Phe Leu Ser Asn Thr Lys Tyr Tyr Asp
65   70   75   80

Asp Ser Gln Tyr Tyr Phe Asn Lys Asp Thr Gly Val Ile Tyr Gly Leu
                85   90   95

Asn Ser Thr Glu Thr Ile Thr Thr Gly Phe Asp Leu Asn Cys Tyr Tyr
                100   105   110

Leu Val Leu Pro Ser Gly Asn Tyr Leu Ala Ile Ser Asn Glu Leu Leu
        115   120   125

Leu Thr Val Pro Thr Lys Ala Ile Cys Leu Asn Lys Arg Lys Asp Phe
    130   135   140

Thr Pro Val Gln Val Val Asp Ser Arg Trp Asn Asn Ala Arg Gln Ser
145   150   155   160

Asp Asn Met Thr Ala
                   165

<210> 29
<211> 165
<212> PRT
<213> human enteric coronavirus

<400> 29

Tyr Arg Ser Leu Thr Phe Val Asn Val Pro Tyr Val Tyr Asn Gly Ser

```
1                5                10                    15
```

```
Ala Gln Ser Thr Ala Leu Cys Lys Ser Gly Ser Leu Val Leu Asn Asn
                20              25              30
```

```
Pro Ala Tyr Ile Ala Arg Glu Ala Asn Phe Gly Asp Tyr Tyr Tyr Lys
            35              40              45
```

```
Val Glu Ala Asp Phe Tyr Leu Ser Gly Cys Asp Glu Tyr Ile Val Pro
    50              55              60
```

```
Leu Cys Ile Phe Asn Gly Lys Phe Leu Ser Asn Thr Lys Tyr Tyr Asp
65              70              75                    80
```

```
Asp Ser Gln Tyr Tyr Phe Asn Lys Asp Thr Gly Val Ile Tyr Gly Leu
            85              90              95
```

```
Asn Ser Thr Glu Thr Ile Thr Thr Gly Phe Asp Phe Asn Cys His Tyr
            100             105             110
```

```
Leu Val Leu Pro Ser Gly Asn Tyr Leu Ala Ile Ser Asn Glu Leu Leu
        115             120             125
```

```
Leu Thr Val Pro Thr Lys Ala Ile Cys Leu Asn Lys Arg Lys Asp Phe
    130             135             140
```

```
Thr Pro Val Gln Val Val Asp Ser Arg Trp Asn Asn Ala Arg Gln Ser
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```

```
Asp Asn Met Thr Ala
            165
```

```
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<212>  PRT
<213>  hemagglutinating encephalomyelitis virus

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```
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```

```
Ala Gln Pro Thr Ala Leu Cys Lys Ser Gly Ser Leu Ile Leu Asn Asn
                20              25              30
```

```
Pro Ala Tyr Ile Ala Arg Glu Ala Asn Val Gly Asp Tyr Tyr Tyr Lys
            35              40              45
```

```
Ser Glu Ala Asp Phe Ser Leu Ser Gly Cys Asp Glu Tyr Ile Val Pro
    50              55              60
```

Leu Cys Ile Phe Asn Gly Lys Phe Leu Ser Asn Thr Lys Tyr Tyr Asp
65   70   :75   80

Asp Ser Gln Tyr Tyr Phe Asn Lys Asp Thr Gly Val Ile Tyr Gly Leu
              85   90   95

Asn Ser Thr Glu Thr Ile Thr Thr Gly Phe Asp Phe Asn Cys His Tyr
           100   105   110

Leu Val Leu Pro Ser Gly Asn Tyr Leu Ala Ile Ser Asn Glu Leu Leu
        115   120   125

Leu Thr Val Pro Thr Lys Ala Ile Cys Leu Asn Lys Arg Lys Val Phe
    130   135   140

Thr Pro Val Gln Val Val Asp Ser Arg Trp Asn Asn Ala Arg Gln Ser
145   150   155   160

Asp Asn Met Thr Ala
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<220>
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<210> 32
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<220>
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<210> 33
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        Spike gene

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        Spike gene

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<210>   52
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<212>   PRT
<213>   Unknown

<220>
<223>   Presumed T cell epitope

<400>   52

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